6. EDUCATION AND OUTREACH

6.1 Introduction

NASA's founding legislation directs the Agency to expand human knowledge of Earth and space phenomena and to preserve the role of the United States as a leader in aeronautics, space science, and technology. Throughout the 1990s, however, undergraduate and graduate enrollment and the number of doctorates awarded in science and engineering declined by more than 15%. This trend, along with an aging workforce, places an increasing burden on NASA to maintain its level of achievement in science and technology.

The Laboratory's parent organization, The Earth–Sun Exploration Division (ESED—Code 610), has established a Committee for Education and Public Outreach, which is charged with coordinating these activities across the Division. This is a work in progress and no attempt will presently be made to place the Laboratory's activities in the context of an overarching theme; however, several Laboratory members are also on the ESED committee. Scott Braun, Goran Halusa, Paul Newman, and Lorraine Remer, are all working with David Herring, Program Manager for Education and Outreach, to achieve the Committee's objectives. More information may be found at http://esdepo.gsfc.nasa.gov/index.php.

6.2 Education

Interaction with Howard University and Other Historically Black Colleges and Universities (HBCUs)

Partnerships with Howard University:

A part of NASA's mission has been to initiate broad-based aerospace research capability by establishing research centers at the Nation's HBCUs. The Center for the Study of Terrestrial and Extraterrestrial Atmospheres (CSTEA) was established in 1992 at Howard University (HU) in Washington, D.C., as a part of this initiative. It has been a goal of the Laboratory and the Earth–Sun Exploration Division to partner with CSTEA to establish at Howard University (HU)a self-supporting facility for the study of terrestrial and extraterrestrial atmospheres, with special emphasis on recruiting and training underrepresented minorities for careers in Earth and space science.

The Laboratory works closely with HU faculty in support of the Howard University Program in Atmospheric Sciences (HUPAS). HUPAS is the first M.S.- and Ph.D.-granting program in atmospheric sciences at an HBCU and the first interdisciplinary academic program at HU. Scientists from our Laboratory contribute to the HUPAS program as lecturers, advisors to students, and adjunct professors who teach courses. A number of HU students have earned M.S. degrees and are about to earn Ph.D. degrees in atmospheric sciences.

Participation with Howard University on the Beltsville Campus Research Site:

Howard University has for several years been in the process of building a multi-instrument atmospheric research facility at their campus in Beltsville, Maryland. This research facility is part of the NOAA-Howard University Center for Atmospheric Science (NCAS). David Whiteman, Belay Demoz (both Code 613.1), and others from GSFC are assisting in mentoring students and advising with instrument acquisition for the site. One of the main instruments at the site is a world-class Raman lidar built with heavy involvement from Code 613.1. The lidar has begun operations and preliminary work on it was reported at the 2005 annual meeting of the AMS in San Diego. David Whiteman and Belay Demoz helped in the proposing, designing, building, and operating the lidar.

Summer Programs

The Summer Institute in Atmospheric, Hydrospheric, and Terrestrial Sciences was held from June 6–August 12, 2005. The institute is organized by Per Gloersen (614.1) and is hosted by the Earth–Sun Exploration Division (Code 610). It is designed to introduce undergraduate students majoring in all areas of the physical sciences to research opportunities in these areas. After a one-week series of introductory lectures, the students select from a list of research topics and are mentored by a Goddard scientist for a period of nine weeks. At the conclusion of this period, the students give a presentation of their results. Laboratory scientists participating in the institute, students, and research topics are shown in Table 6.1.

Table 6.1 Laboratory Scientists Mentoring Students in the 2005 Summer Institute

Mentor/Code	Student	Topic
Geary Schwemmer, 613.1	Ian Brown	Testing Holographic Optical Elements and Instrument Control.
Belay Demoz, 613.1	Theresa Inman	Observations of Moisture and Temperature Variability in a Non-convective Dryline.
Charles Ichoku, 613.2	Luke Ellison	Visualization and Analysis of Fire Radiative Energy Measurements from MODIS.
Yoram Kaufman, 613.2	Kristen Mihalka	Assessing the Transport of Aerosols Around the World.
Yogesh Sud, 613.2	Andrea May	Intercomparison of Satellite Observations and GOCART Model Aerosol Data with the Aim of Preparing a Realistic Aerosol Data Set for Use in Climate Models.
Santiago Gasso, 613.2	Edward Liske	Characterization of Dust Events in Patagonia Using 15 Years of Weather Observations.
Rob Levy, 613.2	Ed Nowottnick	Correlations of MODIS and PM 2.5 Measurements in the Mid-Atlantic Region.
Yaping Zhou, 613.3	Ahmed Tawfik	An Analysis of Tropical Cyclone Precipitation Using Satellite Observations.

Figure 6.1. Participants in the 2005 Summer Institute. Per Gloersen is at the left.

AMS Fellowship Winners' Visit:

On June 29, 2005 the Earth–Sun Exploration Division hosted a visit to GSFC by a group of AMS Fellowship Winners. The visit was organized by the Laboratory for Atmospheres and consisted of a morning seminar and an afternoon tour of the HU Beltsville site. The AMS Fellowship Program, established in 1991, has awarded over 200 fellowships to students entering their first year of graduate study in the atmospheric or related oceanic or hydrologic sciences, with the total dollars awarded reaching nearly $3.5 million. The program is designed to attract promising young scientists to the AMS-related sciences and provide adequate funding for their first year, allowing the recipients to focus solely on their studies. The AMS is joined by industry leaders and Federal agencies in sponsoring the fellowships, which carry a $22,000 stipend. NASA sponsors four of these fellowships. The students, their areas of interest, undergraduate and graduate universities are listed in Table 6.2.

Table 6.2. 2005 AMS Fellowship Winners Visiting GSFC

Name	B. S. Degree	Undergraduate	Graduate
Brian Tang	Atmospheric Science and Applied Mathematics	Univ. of California, Los Angeles (UCLA)	Massachusetts Institute of Technology (MIT)
Ashton Robinson*	Meteorology	Jackson State	Univ. Oklahoma
Andrew Metcalf	Meteorology	Penn State Univ.	Penn State Univ.
Allen Clark Evens	Meteorology	Florida State Univ.	Florida State Univ.
Corey Potvin	Meteorology	Lyndon State Univ.	Univ. Oklahoma
Matthew Greenstein	Meteorology	Penn State Univ.	State Univ. of New York, Albany (SUNY-Albany)
Heather Coleman	Atmospheric, Oceanic, and Environmental Science	UCLA	Univ. California-Santa Barbara
Timothy Whitcomb*	Atmospheric Science	Univ. of Washington	MIT
Nathan Snook	Meteorology	Iowa State Univ..	Univ. Oklahoma

* Indicates NASA sponsored fellowship

During the morning seminar, presentations were given by scientists from the Laboratory for Atmospheres (Code 613), the Hydrospheric and Biospheric Sciences Laboratory (Code 614), and the Global Modeling and Assimilation Office (GMAO, Code 610.1)). The agenda consisted of the following:

Welcome and opening remarks
Dr. Marshall Shepherd: Mesoscale Atmospheric Processes Branch (Code 613.1)

"On the Cause of the 1930s Dust Bowl"
Dr. Siegfried Schubert: Global Modeling and Assimilation Office (Code 610.1)

"Hydrospheric Research at Goddard"
Dr. Robert Bindschadler: Hydrospheric and Biospheric Sciences Laboratory (Code 614)

"Two Perspectives on Rainfall: Urban-Induced on Earth, and Methane on Titan"
Dr. Marshall Shepherd: Mesoscale Atmospheric Processes Branch (Code 613.1)

"The Aura Project"
Dr. Anne Douglass: Atmospheric Chemistry and Dynamics Branch (Code 613.3)

"Ozonesonde Networks for Study of Atmospheric Processes, Satellite Validation and Trends"
Ms. Jacquie Witte: SSAI

Figure 6.2. Dr. Marshall Shepherd (back to camera) in discussion with some of the AMS Fellowship winners during a lunch break.

During the afternoon, a tour of the Howard University Beltsville facility was lead by Prof. Demetrius Venable, Chairman of the Howard University Physics Department and Prof. Everett Joseph of the same department. The tour agenda was:

1:00–1:15 PM	Conference Room Introduction to Howard University Beltsville Site (Venable, Joseph)
1:15–1:30 PM	Tour of O_3 Lab and Doppler Radar Facility (O_3 Team)
1:30–1:40 PM	Walk to Telescope/Tower Site
1:40–2:00 PM	Radiation and Sounding Sites (Nzeffe, Robjhon, Walford)
2:00–2:15 PM	Lidar and Telescope (Venable, Connell, Walford)
2:15–2:30 PM	31 m Tower, Flux Site (Robjhon, Davis)
2:30–2:45 PM	MDE Air Quality Monitoring Site (Venable, Joseph)
2:45–3:00 PM	Return to main building, departure

Figure 6.3. Profs. Venable (cap) and Joseph (back to camera), and Howard University graduate students discuss the Doppler Radar installation with AMS Fellowship students at the Beltsville site. The base of the radar tower is visible in the upper right corner of the photograph.

University Education

Laboratory members are active in supporting university education through teaching courses and advising graduate students.

Table 6.3. Courses Taught in 2005

University	Course	Instructor
UMBC	Physics 622, Atmospheric Physics II	Steven Platnick
Howard University	Atmospheric Chemistry II	Richard Stewart
George Mason University	Thermodynamics	Yogesh Sud
UMCP	ESSIC 234, Cycles in the Earth System	Warren Wiscombe
UMCP	METO 401, Global Environmental Problems	Warren Wiscombe

Table 6.4. Graduate Student Advising by Laboratory for Atmospheres Members

Member/Code	Student	Degree	Institution	Thesis Topic or Area
John Burris, 613.3	John Outerbridge	Ph.D.	Univ. Alabama	Measurement of tropospheric ozone with lidar
	Shi Kuang	Ph.D.	Univ. Alabama	Modeling tropospheric ozone
Belay Demoz and David Whiteman, 613.1	Felicita Russo	Ph.D.	UMBC	Lidar measurement of aerosols and clouds
	Antonia Gambacorta	Ph.D.	UMBC	AIRS water vapor retrievals
	Menghs G. Mariam	Ph.D.	UMBC	Not defined
	Segayle Walford	Ph.D.	Howard Univ.	Lidar boundary layer height characterization
	Rasheen Connel	Ph.D.	Howard Univ.	Not defined
	Scott Rabenhorst	Ph.D.	UMCP	Mesoscale applications of Raman lidar
David Starr, 613.1	Likun Wang	Ph.D.	Univ. Alaska	Homogeneity of Midlatitude Cirrus Cloud Structural Properties Analyzed from the Extended FARS data set
	Robert Carver	Ph.D.	Penn. State Univ.	Understanding Subtropical Anvil Cirrus: A Coupled-Model Study
Joanna Joanna Joiner, 613.3	Paul Poli	Ph.D.	UMBC	Assimilation of global positioning system radio occultation measurements into numerical weather forecast systems
Lorraine Remer, 613.2	Robert Levy	Ph.D.	UMCP	Development of aerosol retrieval algorithm from satellite for specific use in air quality
	Brian Vant-Hunt	Ph.D.	UMCP	Investigation of aerosol–cloud interactions in the boreal and tropical forests using satellite retrievals
Scott Braun, 613.1	Joseph Olson	Ph.D.	SUNY-Stonybrook	Impact of coastal orography on landfalling cold fronts
Mian Chin/613.3	Hongqing Liu	Ph.D.	UMCP	Not determined
Gerry Heymsfield/613.2	Haiyan Jiang	Ph.D.	Univ. Utah	Microwave studies of rainfall

Peter Colarco/ ESSIC	Rebecca Matichuk	Ph.D.	Univ. Colorado	Optical properties of Southern African biomass burning aerosols
William Lau, 613	Massimo Bollasina	Ph.D.	UMCP	Aerosol-monsoon water cycle interactions
	Stephen Chen	Ph.D.	UMCP	Mechanism for forcing of the Pacific High
	Wen Mi	Ph.D.	UMCP	Characteristics of aerosol forcings in East Asia

Laboratory members participate with faculty at several joint centers identifying students whose research interests are shared by a faculty member and a Laboratory scientist. Students are encouraged to visit Goddard and it is anticipated that the Laboratory member will serve on the student's thesis committee. The following table lists students currently supported.

Table 6.5. Graduate Students Supported at the Joint Centers

Student	University	Topic	Advisor/Sponsor
Kevin Mallen	CSU	Radar analyses and studies of precipitation systems	Michael Montgomery (CSU)/ Scott Braun (GSFC)
Maike Ahlgrimm	CSU	GLAS-derived cloud climatologies	Dave Randall (CSU)/ Jim Spinhirne/ Steve Palm (GSFC)
Chris Danforth	UMCP	Chaos processes in general circulation models/GCMs	David Levermore/Eugenia Kalnay (UMCP), Robert Cahalan (GSFC)
Stephen Penny	UMCP	Innovative numerical methods in geophysical problems	Charles D. Levermore (UMCP), Warren Wiscombe (GSFC)
Felicita Russo	UMBC	Micropulse lidar extinction measurements using Raman lidar	Ray Hoff (UMBC), David Whiteman (GSFC)
Antonia Gambacorta	UMBC	Raman lidar studies of water vapor, cirrus cloud, optical depth, particle size, and ice water content	Ray Hoff (UMBC), David Whiteman (GSFC)

CSU: Colorado State University
UMBC: University of Maryland, Baltimore County

6.3 Open Lecture Series

One aspect of the Laboratory's public outreach is a Distinguished Lecturer Seminar Series, which is held each year. Most of the lecturers are from outside NASA and this series gives them a chance to visit with our scientists and discuss the latest ideas from experts. The following were the lectures presented in 2004.

January 27: Warren Wiscombe

NASA's Goddard Space Flight Center, Laboratory for Atmospheres, Greenbelt, MD;
"The Brouhaha over Enhanced Absorption of Sunlight by Clouds: What Went Wrong"

February 10: David Starr

NASA's Goddard Space Flight Center, Laboratory for Atmospheres, Greenbelt, MD;
"Current Issues in Cirrus Cloud Microphysics"

February 24: Tom Ackerman

DOE Atmospheric Radiation Measurement (ARM) Program, Pacific Northwest National Laboratory, Richland, WA;
"Ground-based Measurements of the Atmosphere: The ARM Experience"

March 24: Ralph Kahn

NASA's Jet Propulsion Laboratory / Caltech;
"What MISR Multi-Angle Imaging Contributes to Our Picture of Atmospheric Aerosols"

May 19: Donald Blake

Department of Chemistry, University of California, Irvine;
"Chinese Urban VOCs, Enhanced Alkanes Throughout the Rural Southwest United States, and Preliminary Breath Study Results"

June 15: Graham Feingold

NOAA Environmental Technology Laboratory;
"How Can We Understand the Causes of the Variations of Earth's Global Energy and Water Cycle"

August 17: Dave Randall

Department of Atmospheric Science, Colorado State University;
"Counting the Clouds"

September 15: Bill Frank

Penn State University, Department of Meteorology;
"A Global Look at Waves and Tropical Cyclogenesis"

November 3: V. Ramanathan

Scripps Institution of Oceanography, University of California at San Diego;
"Global and Regional Climate Changes: The Next Few Decades"

December 2: Robert A. Houze, Jr.

University of Washington;
"Deep Convection in the Asian Monsoon"

6.4 Project Outreach

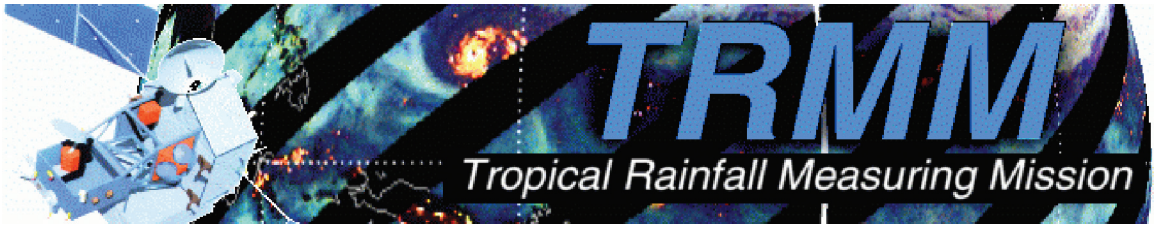
Funded projects in which Laboratory members participate contain elements of both education and public outreach that are described on the project Web sites. Some of these outreach efforts are summarized in the following sections.

TERRA

The EOS Terra outreach effort—under the direction of Yoram Kaufman (Code 613.2), Jon Ranson (Code 614.4), and David Herring (Code 613.2) is a coordinated effort to foster greater cooperation and synergy among the various outreach groups within the EOS community. The Terra mission is designed to improve understanding of the movements of carbon and energy throughout Earth's climate system.

The "About Terra" link on the TERRA home page (http://terra.nasa.gov) contains links to five tutorials designed to inform the public about the importance of the physical parameters observed by the instruments aboard the Terra spacecraft. These tutorials deal with the properties of aerosols, changes in cloud cover and land surface, the Earth's energy balance, and the role of the oceans in climate change. The home page also contains 14 direct links to topics maintained by the Earth Observatory, an outreach site of the Committee for Education and Public Outreach. These links discuss a wide range of topics including Antarctica, flood plains, glaciers, air pollution, and volcanoes discussing each in the context of Terra observations and why such observations are important.

TRMM

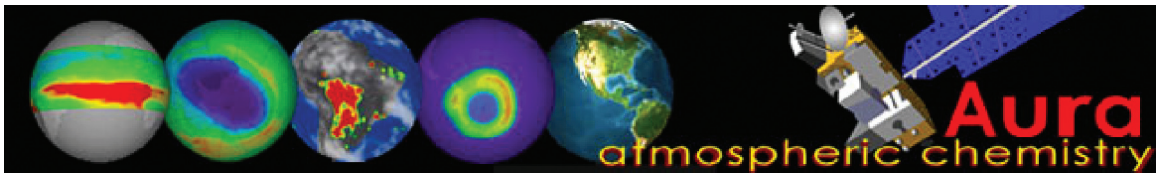


TRMM is a joint mission between NASA and the Japan Aerospace Exploration Agency (JAXA) designed to monitor and study tropical rainfall. TRMM continues its comprehensive Education/Outreach program, in which Laboratory personnel promote TRMM science and technology to the public under the leadership of TRMM Project Scientist Robert Adler (613), and TRMM Education and Outreach Scientist Jeffrey Halverson (613.1/UMBC). TRMM has also included the development of broadcast visuals and educational curriculum in its outreach activities. The Educational Resources link on the TRMM home page leads to five problem-based classroom modules in PDF format. These manuals are titled "Investigating the Climate System" and consist of tutorials on clouds, winds, precipitation, weather, and energy. The first four are appropriate for students in grades 5–8, the last is directed at students in grades 9–12. These packages are available on the TRMM Web site (http://trmm.gsfc.nasa.gov/) and have been reviewed as a part of the Earth Science Enterprise (ESE) Education product review. There are also 11 educational videos that give brief tutorials on various aspects of the TRMM project and on the atmosphere's water and energy cycles.

Global Precipitation Measurement (GPM)

The GPM is a follow-on and expanded mission of the current ongoing TRMM. GPM is one of the Earth Observation Satellite programs, mainly initiated by JAXA, the National Institute of Information and Communications Technology (NICT) and NASA. Both the 'Science' and 'Public Outreach' links on the GPM Web site (http://gpm.gsfc.nasa.gov/index.html) contain a wealth of educational materials. The Science page begins with a tutorial, 'The Science of Measuring Precipitation: Why It Matters' that is followed by links to seven additional discussions of the satellite, its instruments, and what will be measured.

EOS Aura



The Aura satellite was launched from Vandenberg AFB on July 15, 2004. The Laboratory for Atmospheres has responsibility for conducting the Education and Public Outreach program for the EOS Aura mission. Aura's Education and Public Outreach program has four objectives:

(1) Educate students about the role of atmospheric chemistry in geophysics and the biosphere;
(2) Enlighten the public about atmospheric chemistry and its relevance to the environment and their lives;
(3) Inform geophysics investigators of Aura science, and thus, enable interdisciplinary research; and
(4) Inform industry and environmental agencies of the ways Aura data will benefit the economy and contribute to answering critical policy questions regarding ozone depletion, climate change, and air quality.

To attain these objectives, the Aura project supports a strong educational and public outreach effort through formal and informal education partnerships with organizations that are leaders in science education and communication. Our partners include the Smithsonian Institution's National Museum of Natural History (NMNH), the American Chemical Society (ACS), and the Global Learning and Observations to Benefit the Environment (GLOBE) Program. Our goals are to educate students and the public and inform industry and policy makers how Aura will lead to a better understanding of the global environment.

NMNH, working with Aura scientists, will design and create an interactive exhibit on atmospheric chemistry as part of its Forces of Change program. NMNH will convey the role that atmospheric chemistry plays in people's lives through the use of remote sensing visualizations and museum objects.

The ACS has produced special issues of the publication *ChemMatters*. These issues will focus on the chemistry of the atmosphere and various aspects of the EOS Aura mission. The special editions of *ChemMatters* will reach approximately 30,000 U.S. high school chemistry teachers and their students.

The Globe Program (Global Learning and Observations to Benefit the Environment) is a worldwide network of students, teachers (10,000 schools in over 95 countries), and scientists working together to study and understand the global environment. Drexel University's (Philadelphia, PA) ground-based instruments will measure ultraviolet-A (UV-A) radiation and aerosols to support measurements taken from the Aura spacecraft. A tropospheric ozone measurement developed by Langley Research Center is also a GLOBE protocol.

Aura's Education and Project Outreach program will also be present at science and environmental fairs and science and technology conferences to demonstrate how Aura fits in to NASA's program to study the Earth's environment.

TOMS

The Atmospheric Chemistry and Dynamics Branch is committed to quality scientific education for students of all ages and levels. The TOMS Web site contains resource materials for science educators at http://toms.gsfc.nasa.gov/teacher/teacher.html. Three lessons that make use of TOMS data and that study the uses of Earth-orbiting satellites are presented at this site. One of these is directed at students in grades 5–8, others are directed to those in grades 9–12. There is also a link to five projects for independent research, which allow advanced students to learn more about atmospheric chemistry and dynamics.

There is also an online textbook at http://www.ccpo.odu.edu/SEES/ozone/oz_class.htm written by Branch scientists and was designed as an educational resource for the general public, as well as for students and educators. This book contains 12 chapters covering all aspects of the science of stratospheric ozone. Each chapter has numerous low- and high-resolution figures, and ends with a set of review questions.

A TOMS Engineering Model is part of a permanent exhibit entitled "Change is in the Air" at the Smithsonian's NMNH. This exhibit explores the interactions between atmospheric chemistry and climate, emphasizing ozone trends in the stratosphere and the effects of degrading air quality on the environment.